HISTORY AND DEVELOPMENT
of the
WASHINGTON CENTRAL HEATING PLANT

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SUMMARY

During the administration of President Hoover, the Government purchased much additional land in Washington, of which the most important tract was the so-called triangle, south of Pennsylvania Avenue and north of the Mall. An intensive building program was inaugrated, and some engineers and builders, realizing the increasingproblem of heating Gov-buildings, brought the matter to the attention of the Treasury Department.

TheTreasury Department accepted the idea of a Central Heating Plant as the solution to the problem, and accepted the design submitted by United Engineers and Constructors, Inc. of Philadelphia. Neal A.Melick, U. S. Construction Engineer, supervised the entire building of the plant.

Bids were submitted, and contracts let to five companies for the construction, on Oct. 27, I932. At this time excavation for the foundation had been finished, and about one-fifth of the conduit tunnels had been dug. The connerstone was laid on July 7, I933, by L W.Roberts, Jr. of the Treasury Department.

The cost of the entire plant was about $5,000,000, counting the cost of the tunnels, and the plant was built with six boilers to accomodate about 30 government buildings. At this time, 1936, seventy-one buildings are being heated by the plant, while its operation is still under the designed capacity, there is room in the building for two more boilers.

Plant operation was begun on January 15, 1934, and the largest heating plant in the world, with a guaranteed efficiency of 82%, was serving, from C, D, 12th, & 13th Sts., S. W., buildings as far as three-fourths of a mile away.

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FOREWARD

Because of the ever widening program of construction of government buildings in the nation's capital, the problem of supplying them with heat and power had become, in itself, alarmingly large during the past decade. This problem was originally met by installation of individual heating plants in the larger buildings, such as in the Bureau of Engraving and Printing, and by a small network of steam mains from the heating plant at Nineteenth Street and Constitution Avenue.

Later, however, it became evident that such a system was, for reasons shown later, not feasible, and the Washington Central Heating Plant as we know it became a dream of such men as Colonel U. S. Grant, 3rd., Captain F. W. Hoover; the late Mr. James F. Gill; Mr. Charles A. Peters, Jr., of the former office of Public Buildings and Parks of the National Capital; Mr. J. F. Berkley, of the Bureau of Mines; and Messrs. N. S. Thompson and E. W. Goodwin, of the Procurement Division, Treasury Department. These men, among others, realized that if individual plants were installed in each new building, not only would much-needed space be taken up, but many small plants would be undesirable for the following reasons:

(1) Efficiency varies as the size of the heating plant.

(2) The smoke nuisance would be widely diversified and

highly undesirable.

(3) Traffic congestion in downtown areas would be greatly in creased because of transportation of coal and ashes to and from public buildings.

The far-sightedness of these men and of the actual designers is amply attested by these facts: The "ultimate plan" was for the proposed heating plant to accomodate the twenty-seven buildings shown on the accompanying sketch. At present (1936) the plant supplies heat and power to a total of seventy-one buildings and subsidiaries! The fact that space was provided for the enlargement of the equipment from six boilers to eight now seems to have been only a conservative plan for enlargement. However, the equipment as originally installed has been capable of handling the almost trebled requirements, without the necessity of additions, and great flexibility is thus still possible.

With the stage set for the advent of a central plant, plans progressed with alacrity. Under the auspicies of the United States Government, the plant was designed by United Engineers and Constructors, Inc., of Philadelphia, with Paul Phillipe Cret, as associate consulting architect. The Treasury Department, through the brilliant medium of Neal A. Melick, United States Construction Engineer, supervised the building the entire project. He was ably assisted by Herman J. Bounds (shown at right in picture of stokers) and John W. Shonack, assistant Construction Engineer (shown at left in same photograph)

DIAGRAM OF BUILDINGS HEATED BY THE PLANT

Red lines show conduit tunnels. Legend, see next page.

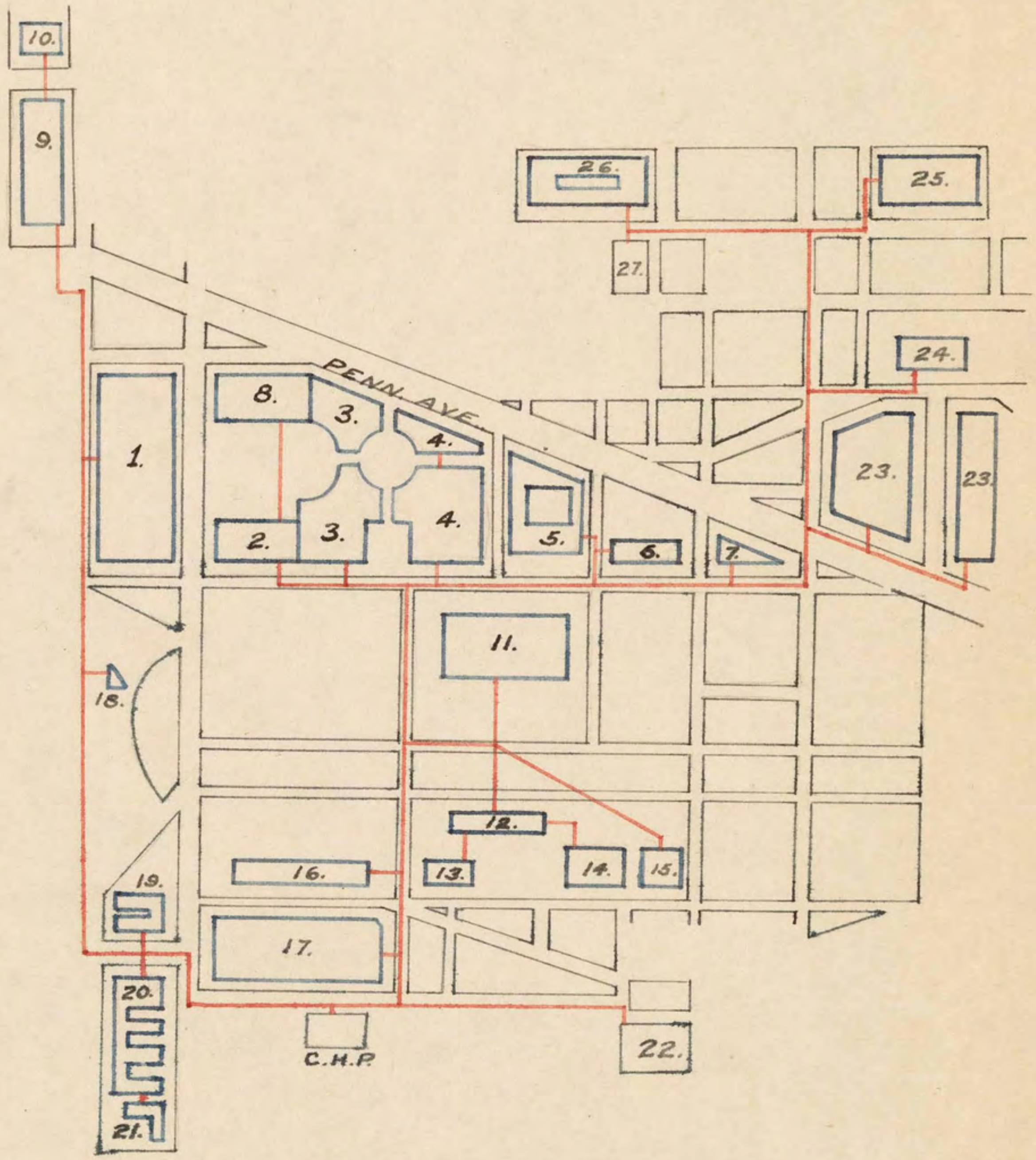


DIAGRAM OF BUILDINGS HEATED BY THE PLANT

1- Commerce Department

2- Labor Dep't. of Interstate Commerce

3- Post Office

4- Internal Revenue

5- Department of Justice

6- Archives Building

7- Apex Building

8- District of Columbia Building

9- Treasury Department

10-Treasury Annex

11-National Museum

12-Smithsonian Institute

13-Freer Art Building

14-Old National Museum

15-Army Medical Museum

16-Department of Agriculture

17-Extensible Building

18-Lodge

19-Auditor's Building

20-Bureau of Engraving and Printing

21-Liberty Loan Building

22-Federal Warehouse

23-Municipal Center

24-Court House

25-Pension Bureau

26-Old Patent Building

27-Land Office Building

PLANT HISTORY

In a formal statement issued April 11, 1931, by Treasurer of United States, details were published concerning the construction of the Washington Central Heating Plant in the square bounded by C, D, 12th and 13th Streets, S.W. It was announced at this time that the decision to actually construct the heating plant had been made subsequent to the acquisition of land by the United States Government, and in accordance with building programs then either under consideration or actual construction.

At that time the plant was designed to furnish heat and power to the twenty-seven buildings shown in the accompanying sketch. The contractors chosen were five: Rust Engineering Co. of Pittsburgh, plant builders; Combustion Engineering Co., New York, boiler engineers; North-eastern Piping and Construction Co., of North Gonawanda, New York, and P. and A. J. Ellis, Washington, D.C. tunnels and piping; and P. J. McDermott, Washington, D.C. excavation.

"The plant is planned ultimately to furnish steam for 26 buildings, which in an average year will consume approximately 1,500,000,000 lbs. steam. The present installation will about 25% less, and the future increases will be taken care of by extending the plant and mains to supply the additional load-------. The buildings which will be supplied with steam and electric light and power in the initial installation will consume approximately 34,000,000 kwh of electric current in an average year, with a maximum demand on the electrical distribution system of approximately 18,000 kw. The future extensions will increase these demands by about 35%. Special

attention will be given to the architectural features of the plant, which will be approved by "The Fine Arts Commission of Washington."

It is of interest to note that so recently as five years ago the "ultimate plan" was to supply steam and power to twenty-six buildings, whereas in reality at this date the number of building extensions and auditoriums have mounted to a total of seventy-one.

On October 27, 1932, the Treasury Department advertized for bids for the foundation and superstructure of the heating plant. In conjunction with the note above, an interesting point is that at this time (October 27, 1932) the plant was stated to be designed for thirty or more buildings. The "ultimate plan" mentioned above by the Treasury Department had, in less than two years, already begun to expand.

At the time of advertisement for bids, about 20% of the then necessary tunnels had been dug, and the boilers were in process of fabrication, in the shops of the Combustion Engineering Co. of New York. Excavation of the plant site had been nearly completed, and were, at the time bids were let, December 1, 1932.

On the 7th July, 1933, the Cornerstone was laid by L. W. Roberts, Jr., Assistant Secretary of the Treasury. At the tome of laying, the plant was characterized as the largest of its kind in the world, and this is still true to-day. It was estimated by this time that thirty eight government buildings would be wupplied with heat and power by the plant, which was virtually all the government buildings except those on Capitol Hill. It was also thought at that time that the plant would

be ready to begin operation about the beginning of 1934. The reasons and advantages of having a central plant for steam production were again brought out by F. P. Fairchild, representing "The United Engineers and Constructors of Philadelphia", present at the ceremony of cornerstone laying, who stated that not only would the cost of steam be less, on any basis, but that the advantages, as pointed out elsewhere, of not having to carry coal and ashes through the city, and the even more important one of easy smoke prevention, would in themselves justify the expenditures for the Washington Central Heating Plant. Neal A. Melick, United States Construction Engineer, presided at the cornerstone ceremony.

For an undetermined reason a slight discrepancy in estimated costs of various government buildings was noted in a published report of the construction program fostered by President Hoover. In the report, published May 13, 1931, estimations for the Washington Central Heating Plant were set at the figure $4,857,023, or about one million dollars under the figure which was submitted to and approved by Congress the following year.

On January 15, 1934, the first carload of coal was delivered to the coal shed of the plant. At the rear of the city block covered by the plant, the coal shed was the first step in the almost completely automatically controlled system. The coal was dumped from the car onto an endless conveyor belt, and proceeded from there through its many stages, as may be seen from an examination of the coal diagram, until it was brought to rest as sluice ashes in the ash shed, only a few feet from its point of delivery.

All the pipe lines had been connected, and needed only the opening of a valve to throw any building into the system. After a fire had been built under one boiler and preliminary tests run on the delivery lines for safety under working pressures, the huge Extensible Building of the Department of Agriculture began receiving steam.

By March 6, 1934, fifteen buildings were being served, and others were cut into the system as occasion demanded. The plant had been officially accepted by The Treasury Department, and the largest and most efficient heating plant in the world was in continual operation.

Since its inception, daily charts have been kept on its operation, and there has never been the slightest breakdown of any kind. One may inspect the plant with mingled feelings, but the two questions that occur to most engineers, or embryo engineers, on leaving, are these:

"Does this plant foretell a future of entirely automatic machine layouts, never needing man's attention?"

"Is there a definite future for immense central heating plants, with boiler pressures of 1500 lbs. and more, and approximately 1500 degrees superheat, as prophesied by some present-day engineers? Will they serve entire cities of the future?"

Perhaps these questions, and others, are beside the point, but their very tone cannot help but entrance us of this day.

PLANT OPERATION

CONTROL

Mention has been made of the fact that the Washington Central Heating Plant is the largest in the world. To one inspecting the plant, the outstanding characteristic of operation is that of automatic control, making possible the automatic operation of the plant over an indefinite period of time.

A master control panel tells at a glance the amount and condition of steam produced, with the amount of fuel used for its production as well as the condition and quantity of the condensate returned to the boilers. This master panel as well as the individual boiler panels discussed later, may be set to operate either by hand - in which case the steam flow may be regulated from one minute to the next - or its setting may be on "automatic", which will keep the flow of steam at an equal level, regardless of any surrounding conditions.

For each of the six boilers there is a sub-control panel. Upon these depend the efficiency of operation:- each boiler must at all times carry its proportionate share of the total load. In addition to information on condition of steam and amount of fuel and returned condensate, the sub-panel likewise allows control of: load adjustment; water level in boiler; and pressures attained by forced draft (supplying air for combustion at grate); induced draft (insuring pressure in chimneys for discharge of flue gases); and pressure necessary in opera-

tion of uptake damper, in chimney. Revolving charts record all the above conditions for the preceeding 24 hour period, and thus a minute by minute record is available from files for any phase of operation since the inception of the plant.

Power activating all seven control panels is supplied by one of two Bailey Air Compressors, supplying air to the panels at 60 lbs. per square inch gage. Power for the compressor is supplied by a 208 volt D.C. motor, drawing 20.3 amps, and producing 3 H.P. at 1745 R.P.M. (60 cycle). The compressors automatically maintain 60 lbs. pressure, and are suplementary.

BOILERS

Steam is supplied by 6 boilers, made by Walsh and Weidner, a division of Combustion Engineering Corporation. Specifications of a boiler are as follows:

Heating Surface, 25,243 square feet

Safe Pressure, 400 lbs. per square inch

Working Pressure, 200 lbs. per square inch

Note: All pressures gage.

Tubes: 4" outside diameter, .185" thick, 45 tubes wide, each 24' long.

Lower bank, 5 tubes high

Upper bank, 16 tubes high

Boiler drum, 60" O.D. 1 9/16 inch welded seam plate

Overall length, 35 feet 4 3/8 inch

Overall furnace width 26' 6"

Overall furnace depth 20' 0"

Feed water inlet, 4", each end

Steam outlet, 12"

Safety valves: 7, graduated every 2 lbs. from 214 to 222 lbs. inclusive.

Efficiency 82% guaranteed, at 129,000 lbs. steam per hour.

Maximum possible operation:

215,000 lbs. steam per hour for 24 hours

237,000 lbs. steam per hour for 2 hours

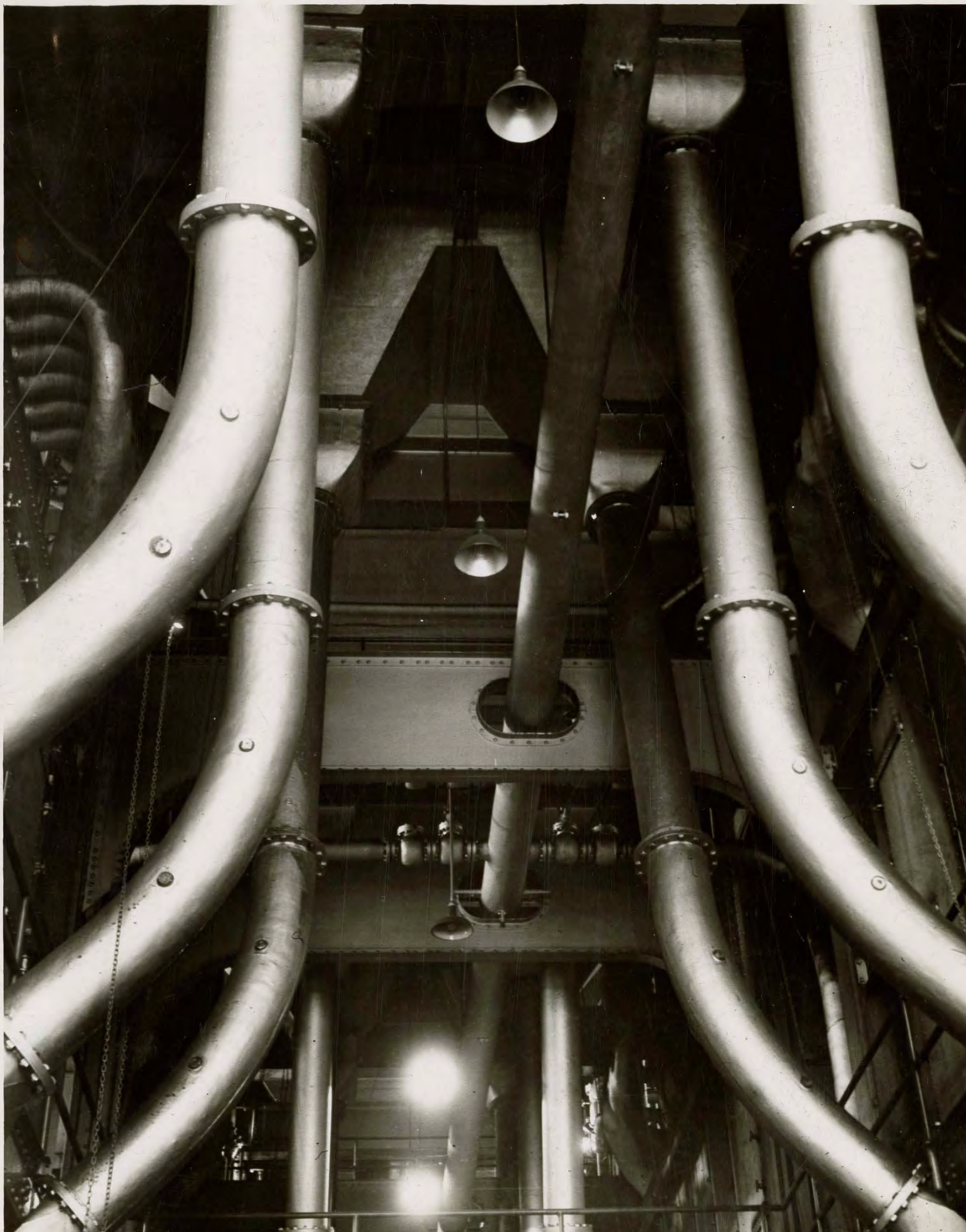
(All conditions for dry saturated steam at 212° F.)

All refractory walls, 9" thick, cooled by air and water, plus 3" plastic insulation above furnace.

Water (see accompanying diagram) is passed through a softener, capacity 70,000 gallons per minute, and thence to a 190,000 gallon treated water storage tank. From the tanks, feed water pumps supply water under 275 lbs. to boilers. This water at 50° F., comprises only 60% of water fed to boilers, as about 40% is returned as condensate through return pipes at 175° F. Both boiler steam temperature and exhaust steam temperature remain nearly constant at about 218° F. There are two boiler feed water pumps per boiler, run by a 2200 R.P.M. single-pressure single-velocity turbine, using steam at 200# and exhausting at 4#. The pump is a Frederick Iron and Steel Pump, 8 stage centrifugal, 675 foot head, backed by a Kingsbury Thrust Bearing, 2000#, 2650 R.P.M., 3 shoes. Pump capacity is 1500 gallons P.M. For summer use a 4 stage pump of 400 G.P.M. driven by a Westinghouse motor.

All time peak operation of the plant as of any one day, was calculated as follows on January 28, 1936:

15, 337, 000 lbs. steam



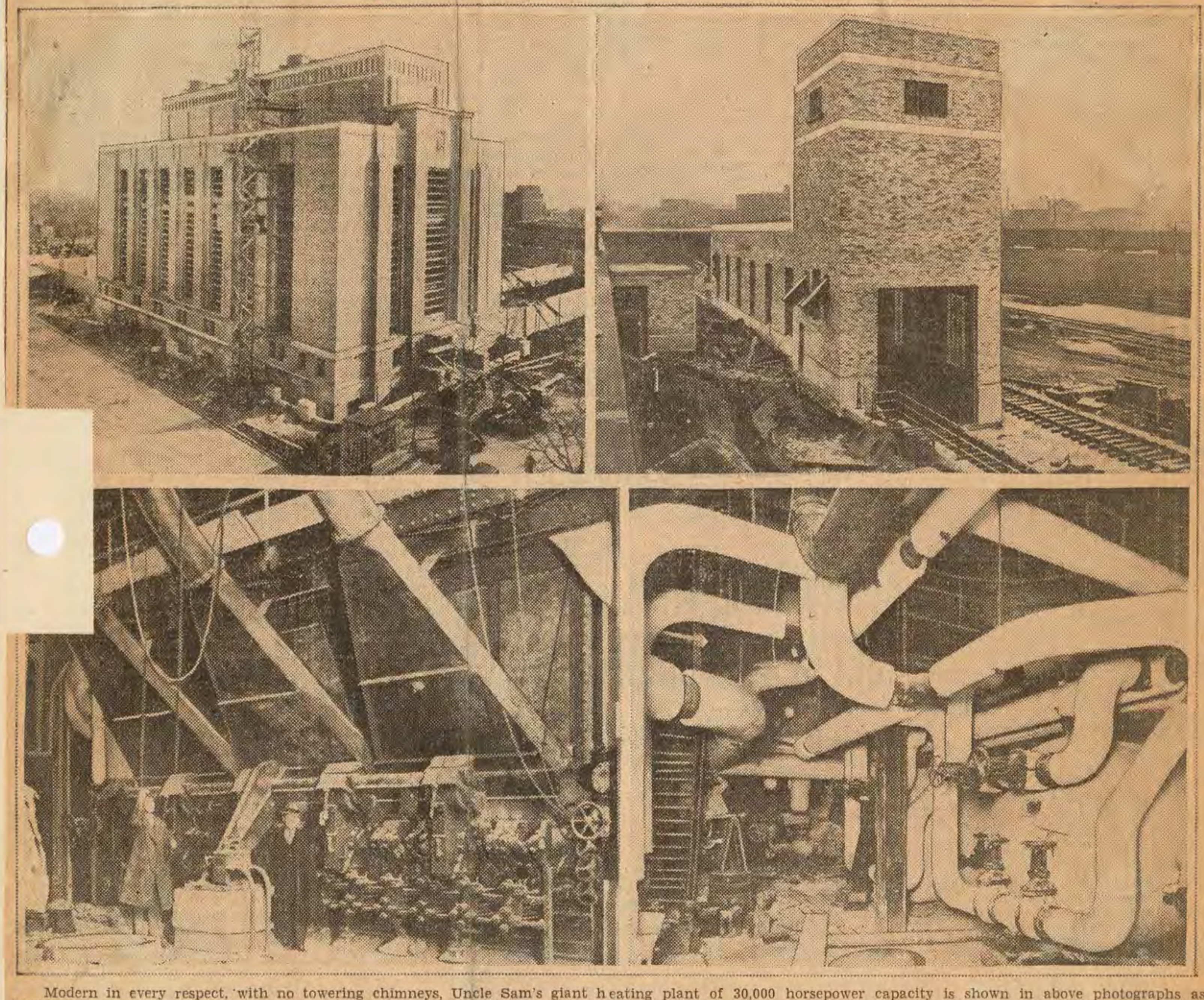
639,000 lbs. steam hourly load

Coal consumed, 728 short tons per day. (Maximum hourly demand occurred on December 26, 1935, when 735,000 lbs. steam per hour was required.) On basis of above figures, average daily use of coal required for steam produced was .095 lbs. coal per lb. steam, or 1 lb. coal produced about 100 lbs. steam.

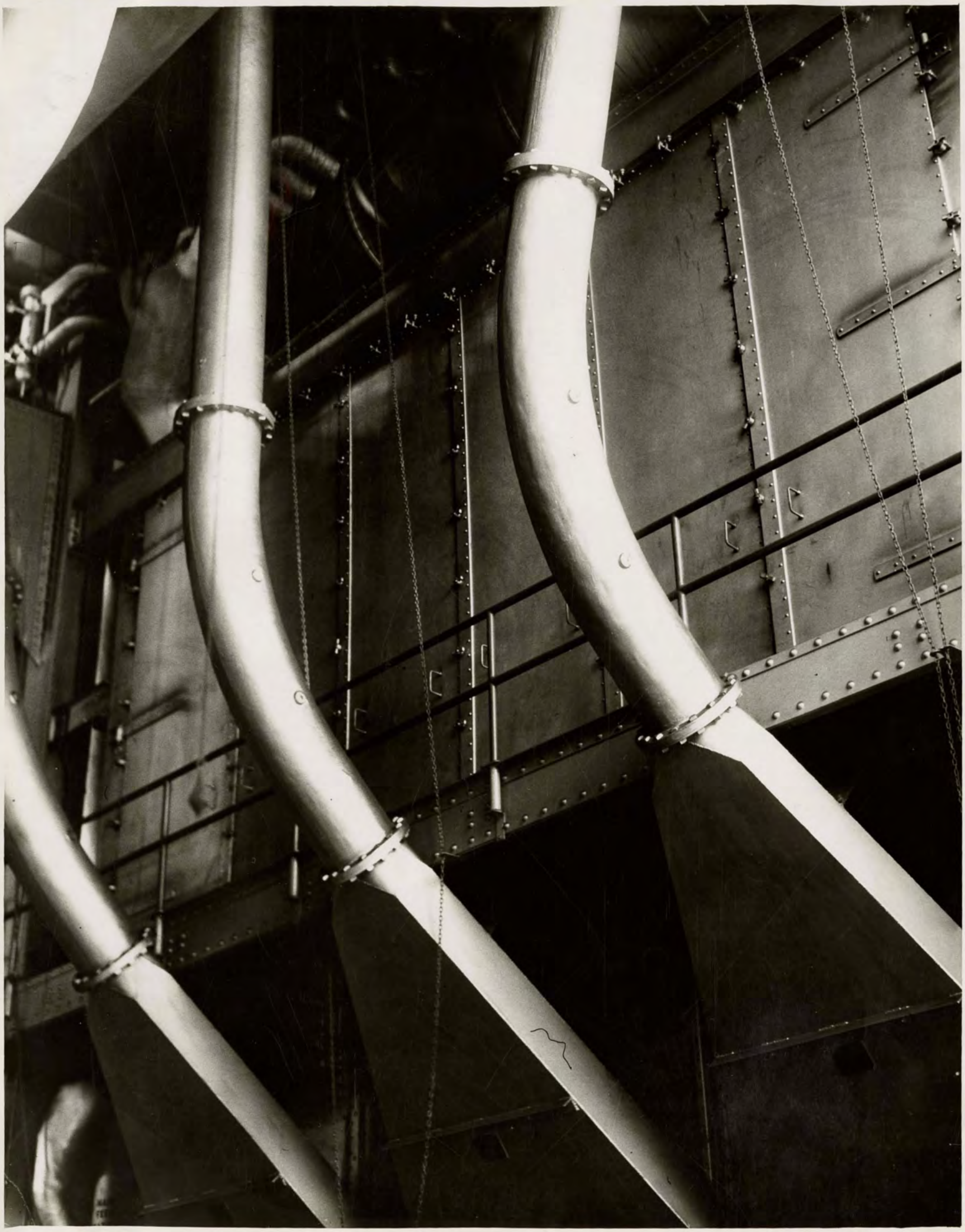
STOKERS AND ASH HANDLING

One of the most noteworthy Characteristics of the Washington Central Heating Plant is the method employed for supplying coal to the furnaces. At its inception, it was the only one in use, and only since has its operation proven so efficient, that many plants have adopted it.

Coal (see diagram) is fed into a rectangular tube from a hopper. In the tube there are 15 rams, working as pistons from a crankshaft outside the furnace. Power is supplied to the crankshaft by a turbo-driven hydraulic oil pump. Oil pressure in the pump is 3 to 6 lbs. S.A.E. "20" oil is used, recirculated, and the pump develops 30 H.P. at 3320 R.P.M. These rams - of variable stroke - push the coal onto the grate, where combustion takes place with air forced from below. The coal is used dry and is Pennsylvania No. 17, bituminous, of 1/4" mesh. The clinker drops to a pre-crusher, where it is ground to a fairly uniform egg size. From the pre-crusher the clinker drops to a sloping platform, from which it is periodically washed by jets of water, to an underground passage. From this passage the water and clinker is pumped by a Westinghouse "Ash Sluicing System" which consists of 100 H.P. centrifugal pumps, and one

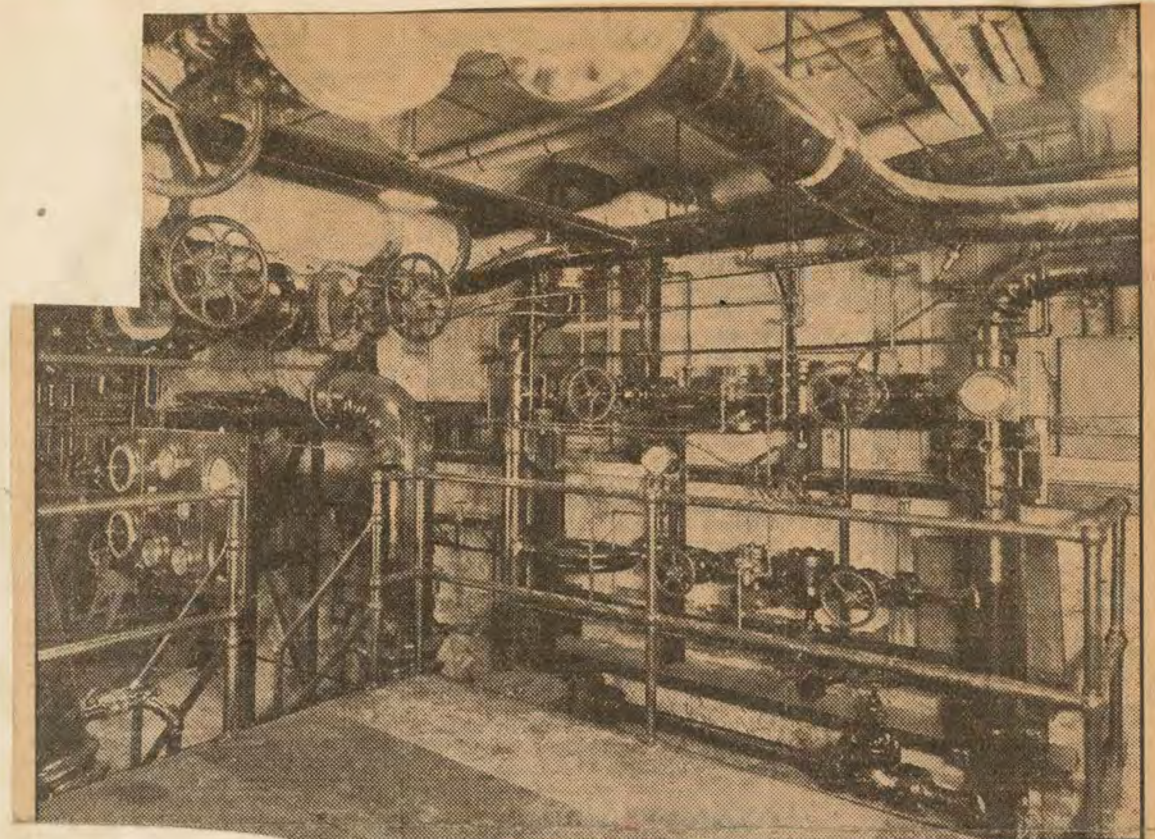


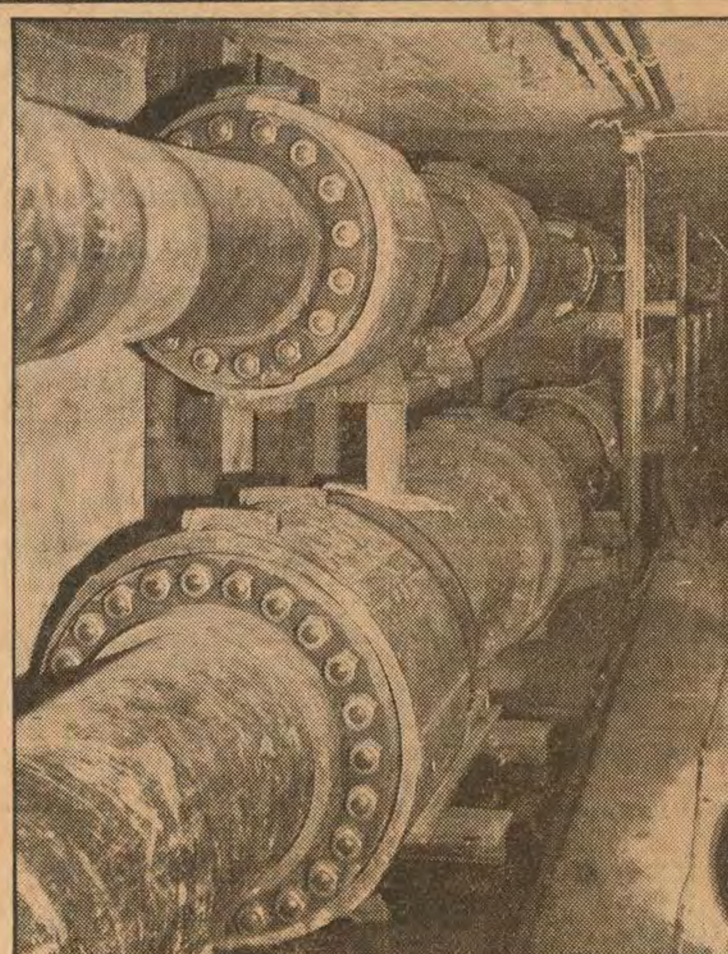
Modern in every respect, with no towering chimneys, Uncle Sam's giant heating plant of 30,000 horsepower capacity is shown in above photographs as engineers prepare to start fires tomorrow. The plant, at left above, shows only tips of its six steel stacks, which soon will be covered with ornamental stainless steel decorations. Coal is brought by rail, dumped in the track hopper house, shown upper left, and carried by conveyor belt through tunnel under D street to plant, where it is hoisted to bunkers. From bunkers it runs down through huge pipes into the automatic stokers (lower left). Herman J. Bounds, U. S. mechanical engineer, at right, and John W. Shorrock, assistant construction engineer who supervised the construction, are shown at controls. Ashes are sluiced out of the pit and pumped by the ash pump house shown alongside the track hopper house, upper right, into the ash storage bin, in top of the track hopper house, for disposition either by railroad or truck. At lower right is shown a maze of basement pipe and filter tank insulation work, where water is softened for boilers in order to prevent scale.



The six chimneys appear as only stubs from outside the plant, if seen at all. Architectural blinds of stainless steel surround each one, and attention is never focussed on them, as the only gases to pass through are colorless and cannot be noted.

In conclusion, my reactions to this brief study of the Washington Central Heating Plant are probably evident throughout this treatise. To my mind, it provides an outstanding bulwark in defense of American engineering, not only because of the vastness and general excellence of the entire layout, but also because of the resourcefulness and inventiveness of the builders, in carrying out the small, but highly important, details of construction. In this connection, notice may be called briefly to the ingenious safety joints, allowing expansion of the huge mains without leakage: an important consideration, as the conduit tunnels are patrolled daily. Also, a thing of seeming simplicity, such as decreasing the pressure of steam from 300 lbs, to radiator pressure, loses some of its simplicity with a glance at the pressure-reducer, in the basement of the Treasury Building, shown in following photograph.





Important parts of the new wide-spreading steam distribution system carrying heat to many Federal buildings from the central heating plant in Southwest Washington are shown above. Top picture, a "single-stage reducing station" in basement of Treasury Department, which reduces the steam pressure from 300 pounds per square inch to lower pressure for radiators, and below, a view of the vital double-expansion joints which allow the huge 18 and 12 inch mains to expand under heat and to slip without leaking steam under high pressure. Lower picture shows also general view of the Fifteenth street steam tunnel looking north.

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